Importance of Electric and Autonomous Car Industry

INI R&C

May 09, 2019

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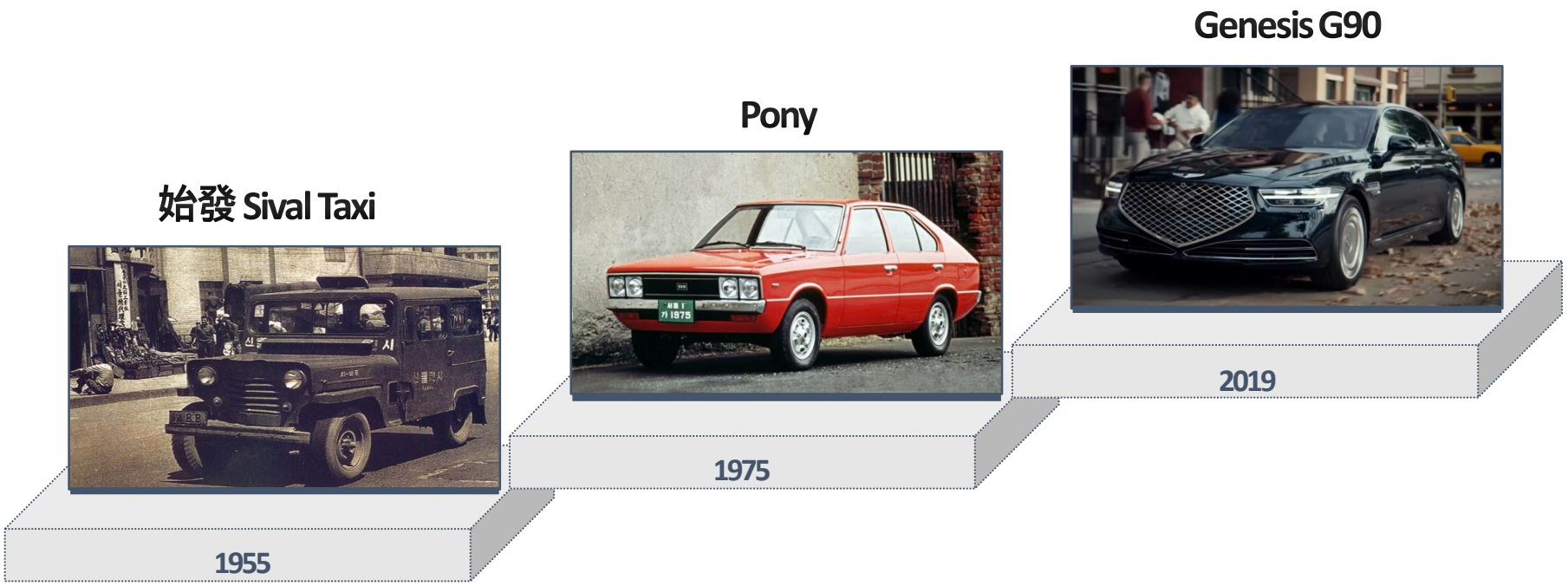
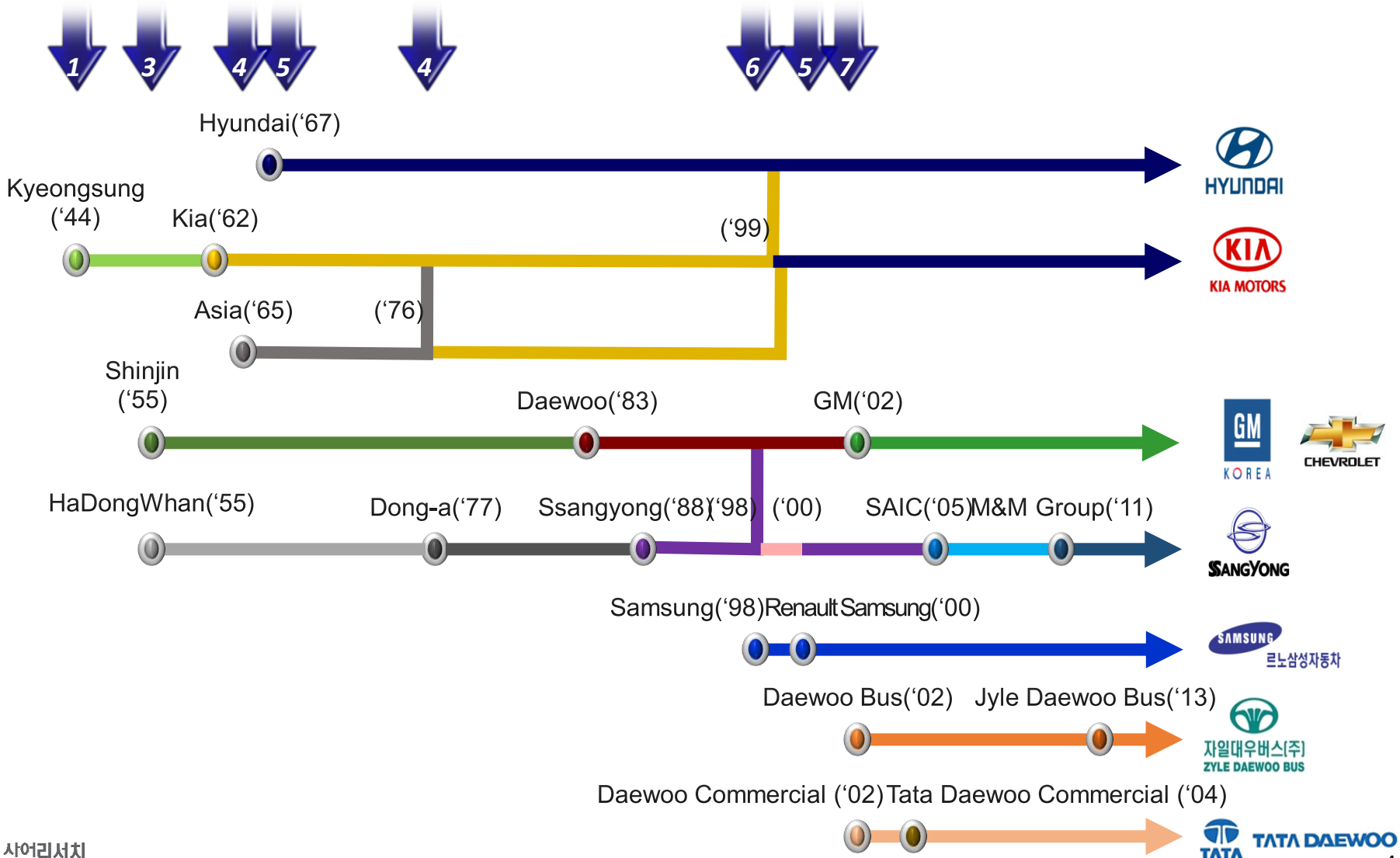
The Korean car, which started in 1955 with the "Sival Taxi", has been repeatedly developed through "Pony" in 1975 and "Genesis G90" in 2019.



As of 2019, Hyundai / Kia Motors, GM Korea, Ssangyong Motor, Renault Samsung Motors, Jyle Daewoo Buses, and Tata Daewoo Commercial Vehicles are producing cars in Korea.

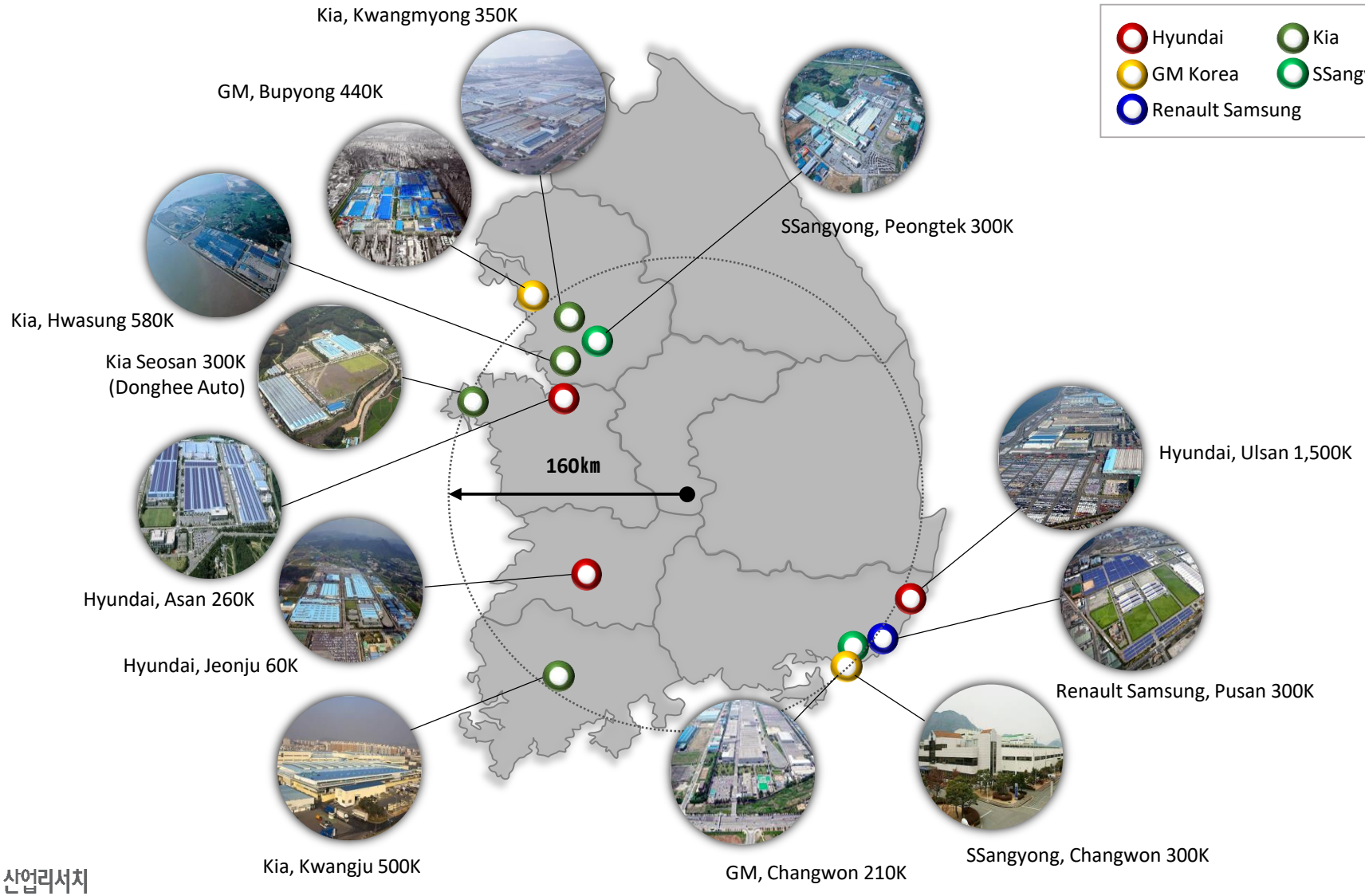


Five domestic passenger car makers have production capacity of 4.35 million units.

In addition, there are two commercial vehicles.

	Hyundai	Kia	GM Korea	Renault Samsung	Ssangyong
	현대자동차	기아자동차	GM Korea	르노삼성자동차	쌍용자동차
Foundation	1967. 12	1944. 12	2002. 8	2000. 9	1954. 1
Location(KR)	Ulsan, Jeonju, Asan	Kwangmyung, Hwasung, Kwangju	Bupyung, Gunsan, Changwon	Busan	Pyungtek, Changwon
Location(W/w)	India, China, US, Turkey, Czech, Russia, Brazil	China, Slovakia, US	-	-	-
Employee	57,105	32,411	15,663	5,000	4,962
Revenue (bil $)	97.3	54.2	10.8	5.6	3.7
Production Capa. (thousand unit)	1,780	1,640	500	300	169

Domestic automobile production plant is mostly concentrated in Chungnam and Gyeongnam province.



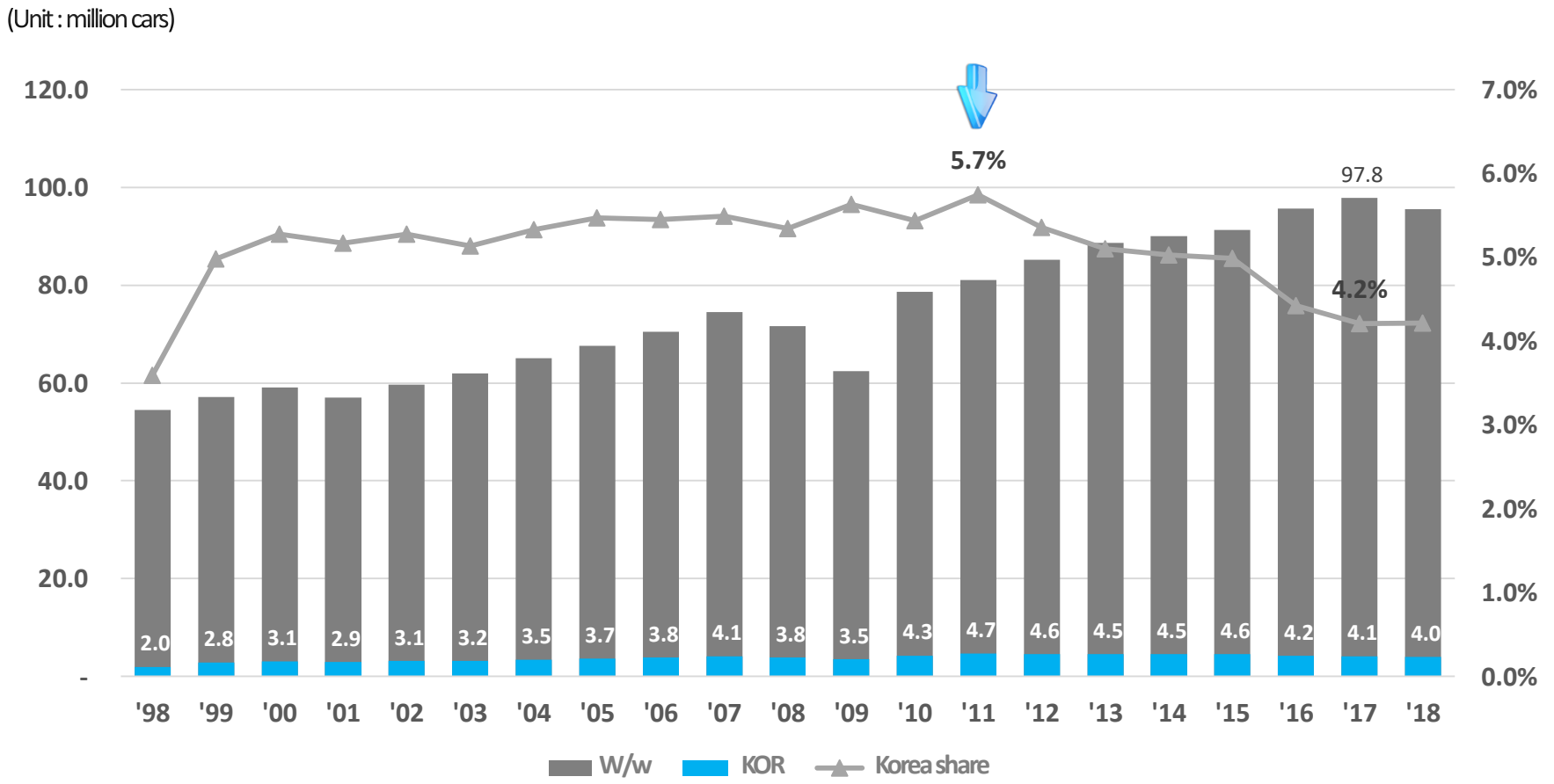
Korea maintains its 5th position since 2010 based on domestic car production, ranking 6th in 2016, and the 7th among countries in the last year.

(Unit : million car)

Ranking	'01	'03	'10	'11	'12	'13	'14	'15	'16	'17	'18	Productions
1	USA	USA	China	China	China	China	China	China	China	China	China	27.81
2	Japan	Japan	Japan	USA	USA	USA	USA	USA	USA	USA	USA	11.31
3	Germany	Germany	USA	Japan	Japan	Japan	Japan	Japan	Japan	Japan	Japan	9.73
4	France	China	Germany	Germany	Germany	Germany	Germany	Germany	Germany	Germany	Germany	5.64
5	Korea	France	Korea	Korea	Korea	Korea	Korea	Korea	India	India	India	5.17
6	Spain	Korea	Brazil	India	India	India	India	India	Korea	Korea	Mexico	4.11
7	Canada	Spain	India	Brazil	Brazil	Brazil	Mexico	Mexico	Mexico	Mexico	Korea	4.03
8	China	Canada	Spain	Mexico	Mexico	Mexico	Brazil	Spain	Spain	Spain	Brazil	2.88
9	Mexico	Brazil	Mexico	Spain	Canada	Thailand	Spain	Brazil	Canada	Brazil	Spain	2.82
10	Brazil	UK	France	France	Thailand	Canada	Canada	Canada	Brazil	France	France	2.33

Domestic vehicle production declined from about 4.6 million cars per year during 2011-2015 to 4 million cars in 2018.

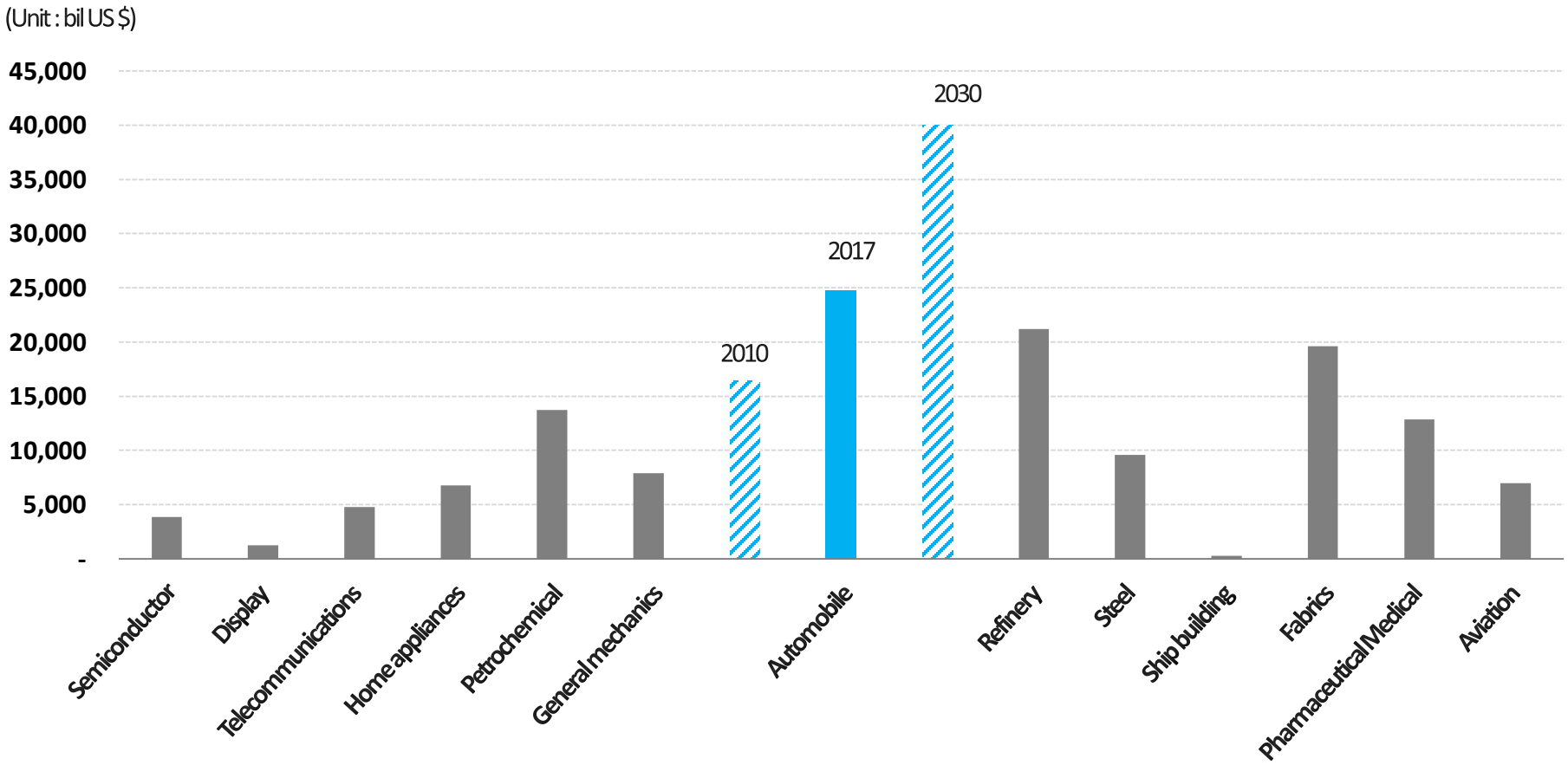
In 2011, domestic automobile production amounted to 4.6mn units, which was the greatest year in terms of production, which occupied 5.7% of global production.



(Source : KOSIS, INI R&C estimates for 2018)

The importance of the automobile industry is even greater than that of any other industry, as it already has a global market of 2,500 billion US $ in 2017.

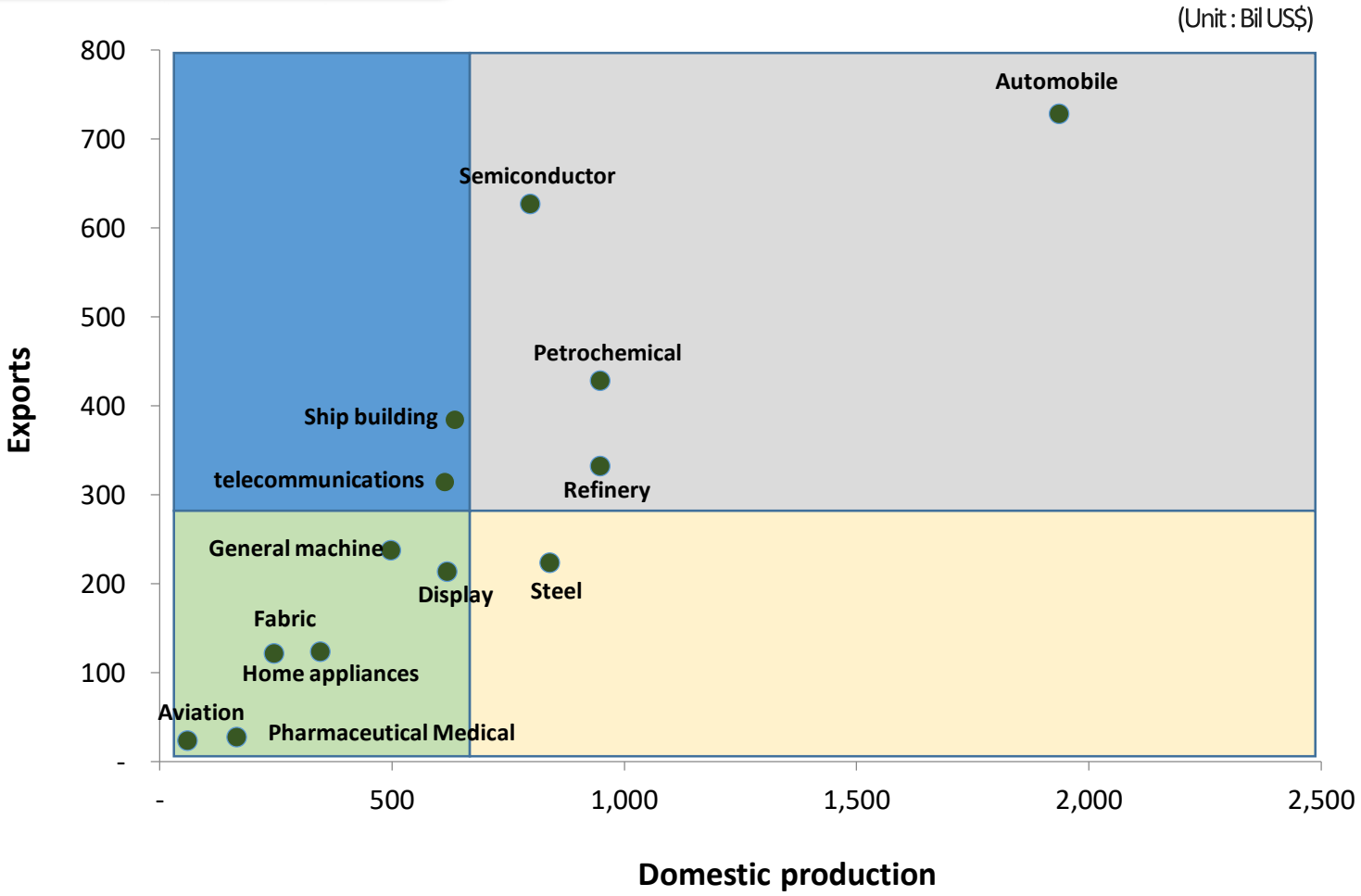
The semiconductor market in which Korea is leading the world is 400 billion $, the display is 130 billion $, and the shipbuilding is only 30 billion $.



* Reconstructing data for each industry by INI R&C on a global market basis in 2017

The automobile industry has the largest amount of production and the largest amount of exports.

Contribution by Industry

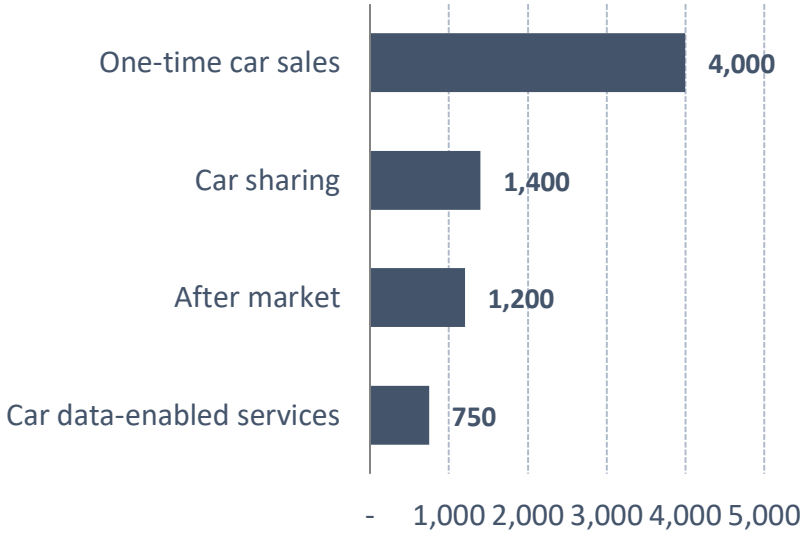


* Reconstructing data on domestic production and exports of each industry in 2017 by INI R&C

The automotive industry has a very large impact on the downstream industries such as the transportation service industry such as car sharing and automobile parts manufacturing and materials.

Global car market size in 2030

(Unit : Bil US$)



(Source : Statisca)

Material industry

Steel, metal, glass, rubber, Plastics, textiles, leather, paints, etc.

Test Research and Production Equipment Industry

Machine tools, automation equipment, molds etc.

Down stream

Automotive industry

Up stream

Auto parts industry

Transportation service

Passenger, cargo transportation, rental, Lease, parking management

Distribution

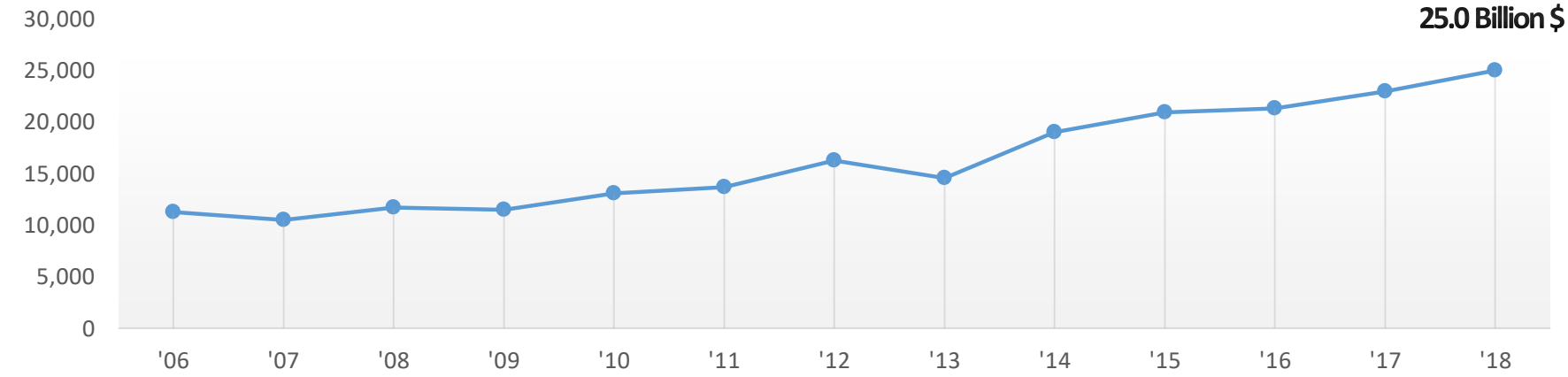
New car sales, used car sales, Parts sales, maintenance, etc.

Construction, oil

Traffic facilities, road construction, refinery, Gas station, insurance, etc.

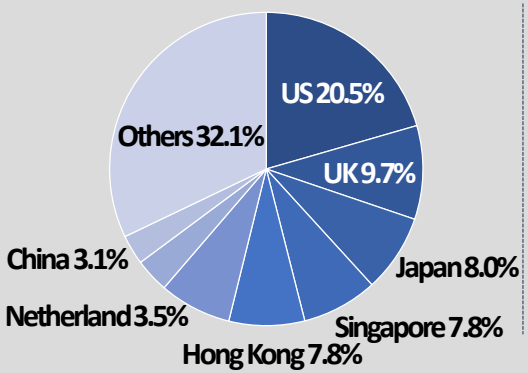
The world's investment in Korea is increasing year by year.

FDI Statistics

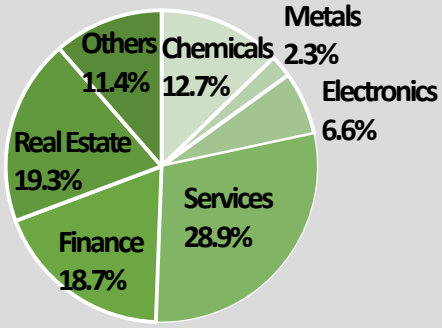


FDI in Korea ('17)

by Country



by Industry



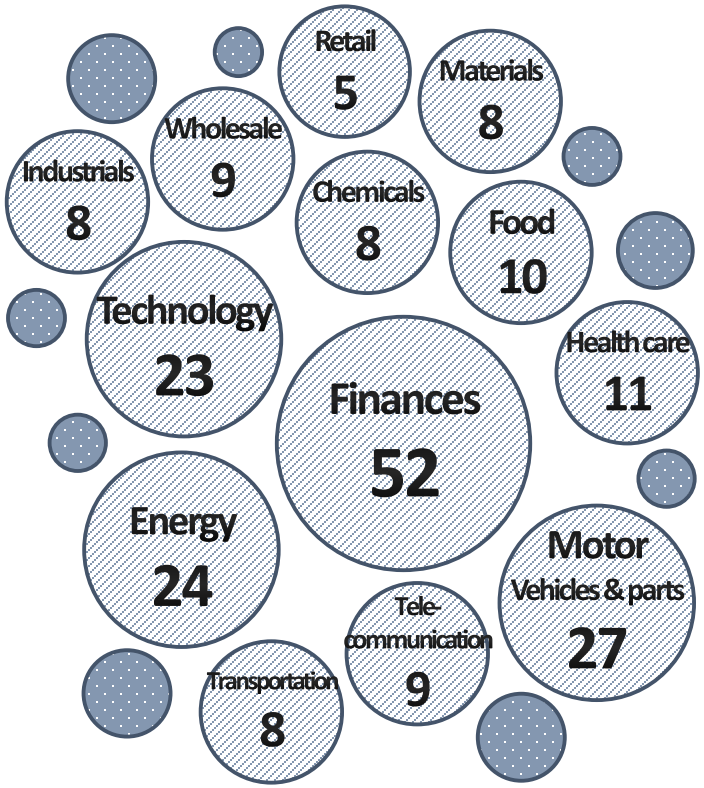
- **Foreign Investment in Korea**
  → Steadily Increasing
- **For three consecutive years**
  → Surpassed $20 Bil
- **EU > US > Japan > Singapore > (China) Hong Kong**
- **FDI의 31.5%**
  → manufacturing industry

(Source : Ministry of Trade, Industry and Energy)

Global companies are investing in Korea's automotive, energy, telecommunications, transportation, healthcare, chemical and materials industries.

223 of Fortune 500 companies Invest in Korea

Major Invest Industries in Korea



1 Importance of Automobile Industry

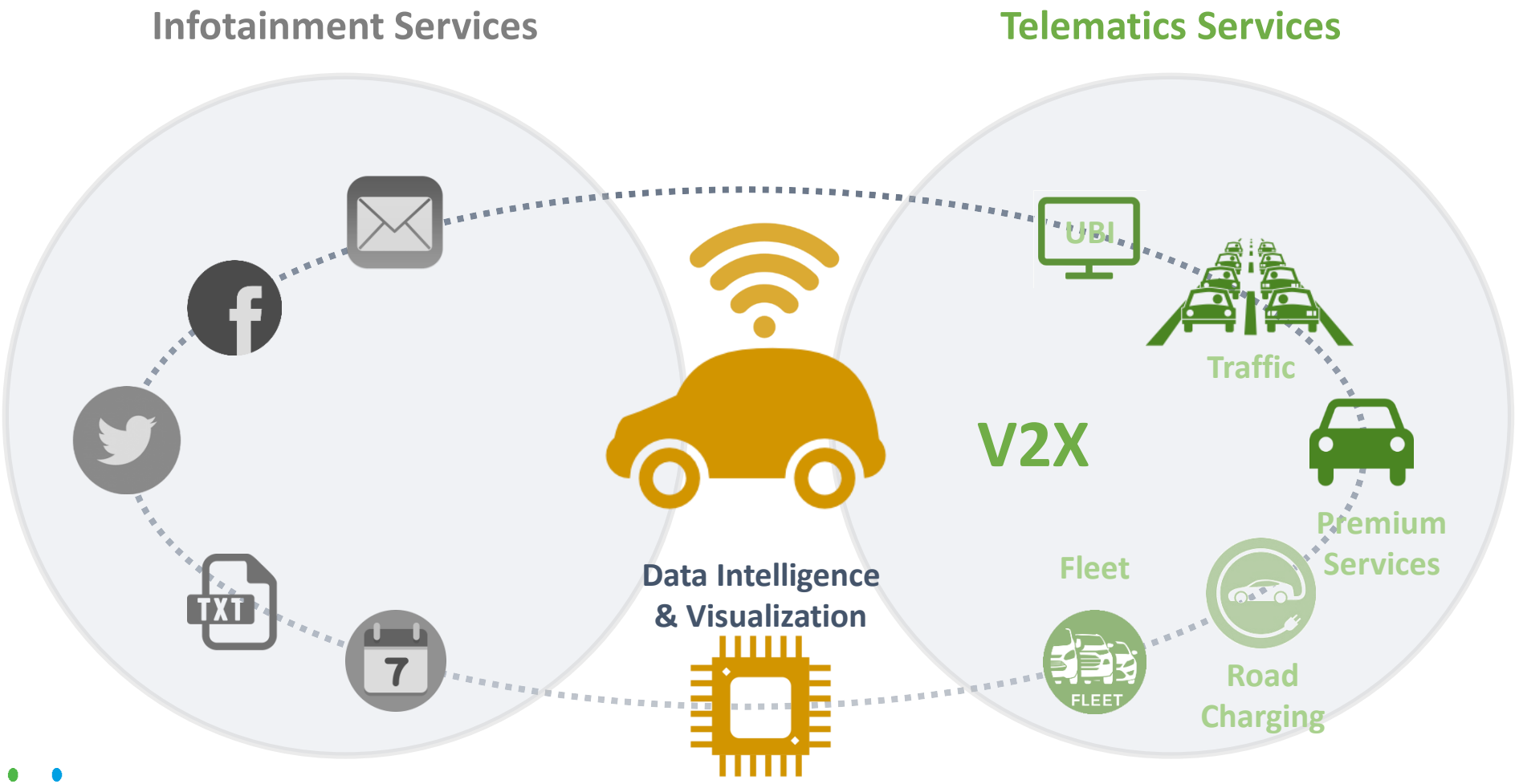
2 The changing automobile industry

The future of the automotive industry can be summarized as C A S E.

Connected, Autonomous, Shared & Services, and Electric

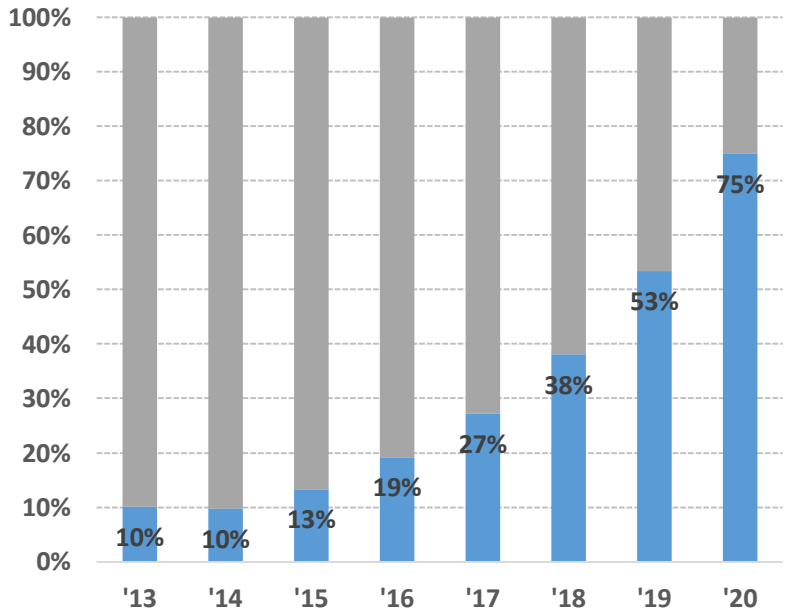
Connected cars evolve into smartphones with wheels.

The concept of Connected Car began with the introduction of OnStar services to GM in the mid-1990s.



In CASE, the connected car market is the first to grow.

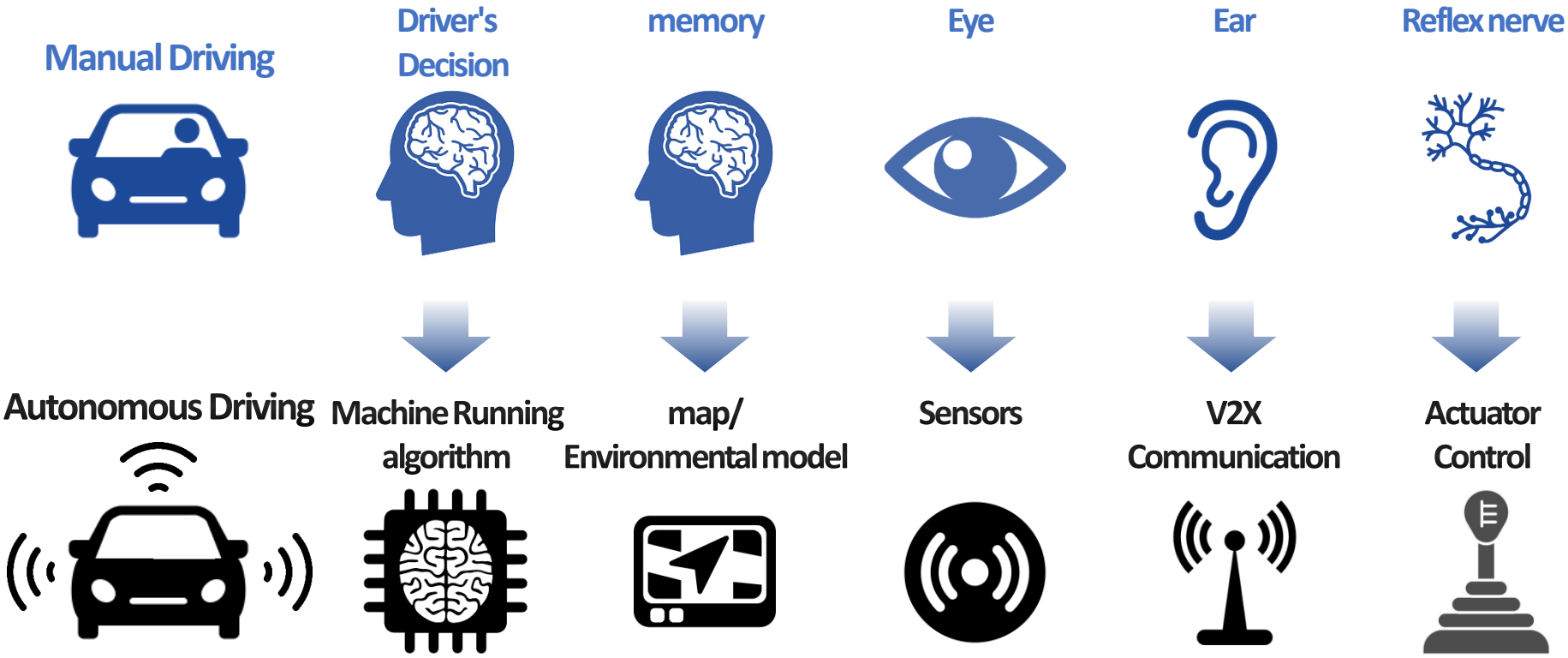
Market size of connected cars



(Source : BI Intelligence)

Connected Car Service

An autonomous vehicle is an automobile that can recognize the danger of a driving environment without the driver controlling the brakes, the steering wheel, and the accelerator pedal, and can safely operate himself by planning the driving route.



6 levels from Level 0 to Level 5

AUTOMATION LEVELS OF AUTONOMOUS CARS

LEVEL 0

There are no autonomous features.

LEVEL 1

These cars can handle one task at a time, like automatic braking.

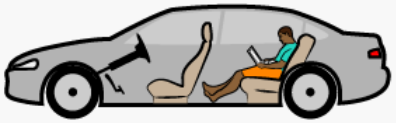
LEVEL 2

These cars would have at least two automated functions.

LEVEL 3

These cars handle “dynamic driving tasks” but might still need intervention.

LEVEL 4



These cars are officially driverless in certain environments.

LEVEL 5

These cars can operate entirely on their own without any driver presence.

The technology of autonomous driving car is composed of driving environment recognition technology (radar / radar / camera etc.), location recognition technology (precision map, GPS, sensor, etc.) Etc.) and interaction technology (HMI / V2X, etc).

Sensors
Recognize external data

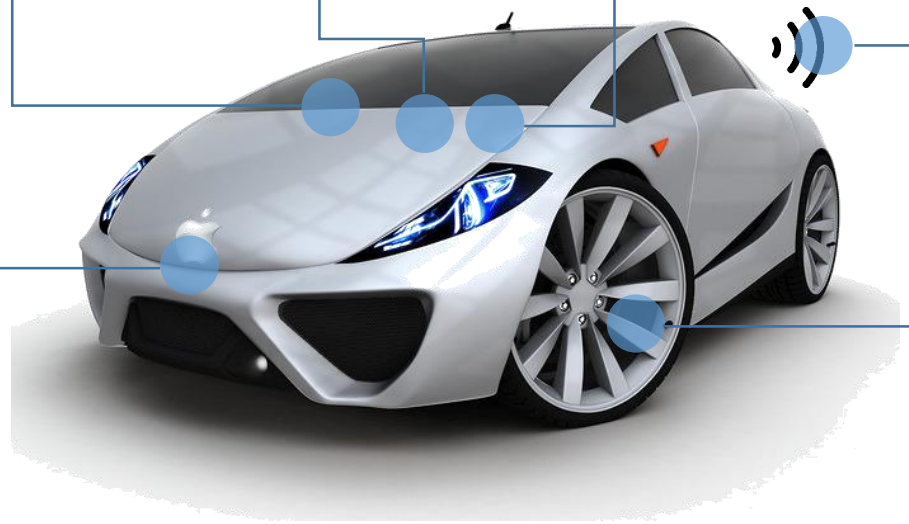
Map
Roads, buildings, and infrastructure information

Processors (ECUs / MCUs)
Decision

Software algorithm

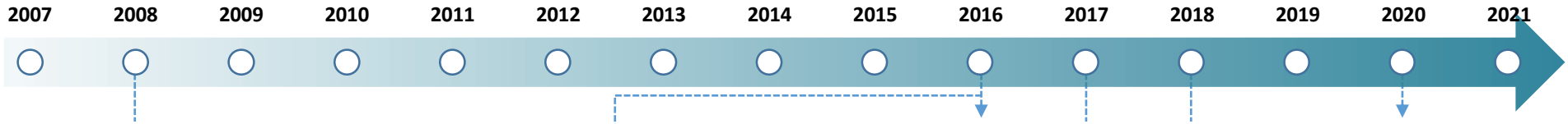
Connected
Vehicle vs. Vehicle
Vehicle vs. Infrastructure

Actuator
Execute decisions immediately



Promoting vertical business model covering HW / SW / Service

Established autonomous navigation department, autonomous navigation joint venture / venture department, electric car and autonomous driving car strategic marketing department



- 2008: Autonomous driving test model "BOSS "
- 2012: $ 500 million invested in vehicle-sharing service Lyft
- 2016: Acquisition of self-driving car start-up cruise ($ 1 billion)
- 2017: 1) Released Cruse EV based Bolt 2) Separate GM Cruise department
- 2018: Acquired Lidar startup Strobe
- 2020: 1)Plan to launch a self-driving car (L4) that can change lanes on the highway 2)Plan to install Super Cruise technology on all Cadillac brand vehicles

"Robot Car" used 15 external sensors

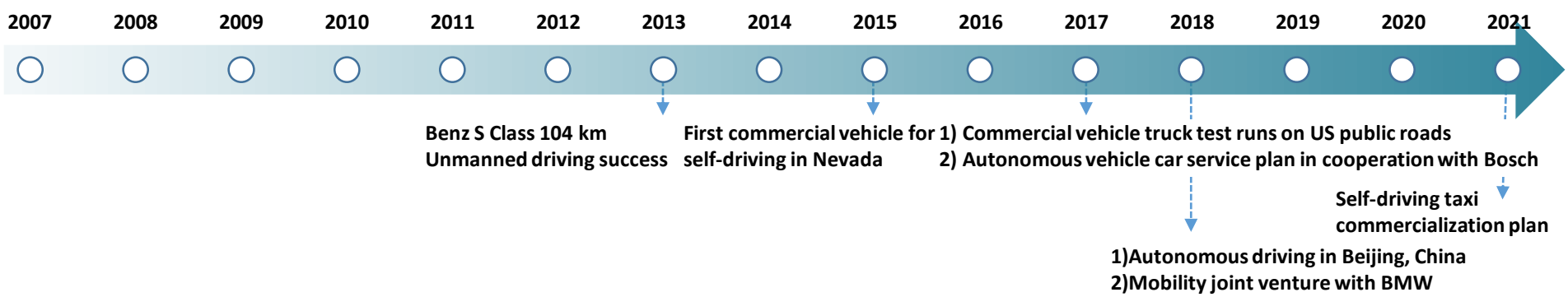
Bolt-based autonomous vehicle "Cruise AV" → 2,500 test driving plans in 7 states

- External investment : In 2018, Softbank invested $ 22.5bn and Honda invest $ 7.5bn in GM Cruise ($ 2bn additional investment) in GM Cruise.
- Lyft, which has invested in 2016, will build a service to enable GM's autonomous vehicles and launch its own service, Maven.

The ultimate goal of GM is to find new revenue sources such as data and services as well as existing revenue sources through the establishment of a fast autonomous driving / shared economic ecosystem.

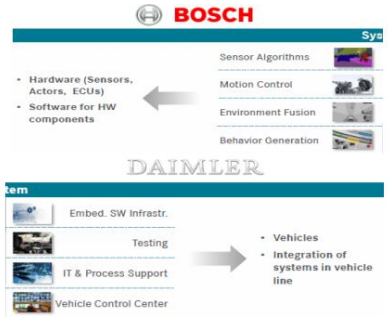
Most hard-working on a sharing economy

Daimler is in the fastest pace to secure autonomous driving technology compared to US car makers, although it is late.

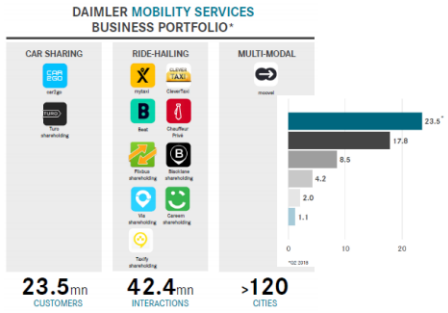


F015 Luxury in Motion (2015)

Concept car 'Smart Vision EQ fortwo'



Cooperation with Bosch



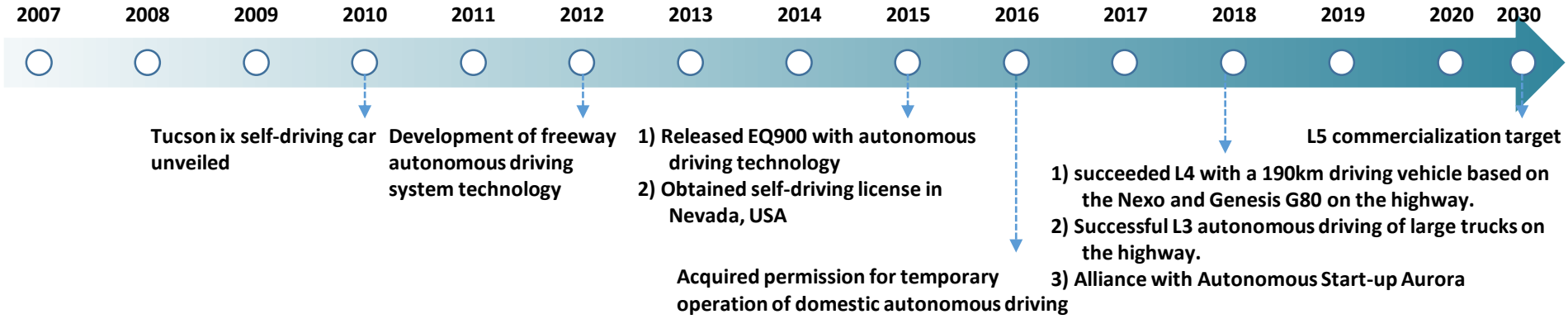
Daimler's Mobility Services

- Daimler acquires Here, a high-precision map service provider, in partnership with BMW/Audi and in February 2017 signed a partnership with Uber.
- And operating as a subsidiary service by acquiring mobility companies such as Car2go, a car sharing service and Mytaxi, a taxi calling service (23.5 million customers as of the end of September 2018)

Positioning strategy as a leading company in the sharing economy era beyond autonomous driving

Realistic response from connected cars

The Hyundai motor plans to start full-scale autonomous operation by 2030, and focuses primarily on autonomous self-driving of connected automobiles.



Hyundai's self-propelled truck test

Hydrogen electric car Nexo autonomous model

Bluelink – connected system

autonomous car partnership

- In July 2017, Hyundai decided to cooperate with Mobile Eye in autonomous vehicle and in 2018, has partnership with the self-propelled start-up Aurora (January), and invested in US radar and AI start-up "Meta-wave"(May), US AI startup 'Perceptive Automata' (October).

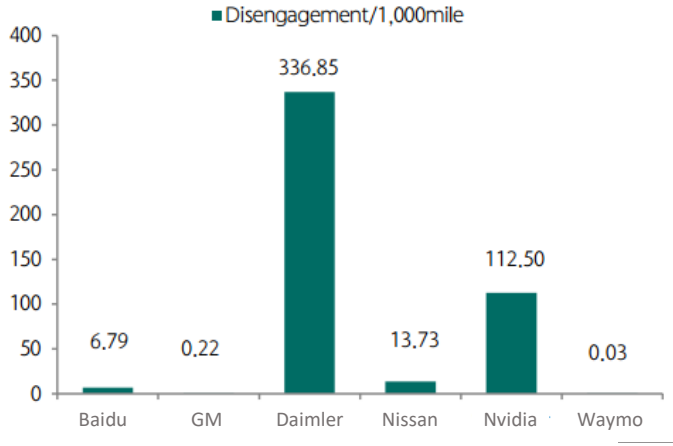
Hyundai aim to develop L4 stage in Smart City by 2021, and to commercialize fully autonomous vehicle by 2030.

Leading development based on superior artificial intelligence technology

Waymo's strengths of autonomous vehicle technology are the sensors covering three soccer fields and the artificial intelligence technology.

2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021

- 2009: Google X autonomous car Project (Prius based)
- 2012: The Lexus RX450h-based autonomous vehicle (Autonomous driving in the inner city)
- 2015: Self-developed steering wheel and pedal-free self-propelled vehicle 'Firefly'
- 2016: Independent as Waymo corporation
- 2017: Pilot of self-propelled minivan 'Pacifica' * Developed "LIDAR"
- 2018: Road test exceeded 10 million miles (accumulation of technology by deep running)



Number of disengagement per 1,000 miles

Google and FCA's autonomous minivan "Pacifica"

Google's autonomous car

- In May 2017, Waymo announced collaboration in autonomous vehicles with Lyft.
- In December 2018, launched a autonomous taxi service (operating a completely self-propelled driving program (L5).
- And was allowed to run a fully autonomous driving test without a driver or auxiliary passenger from the California Department of Car Service (CDMV).

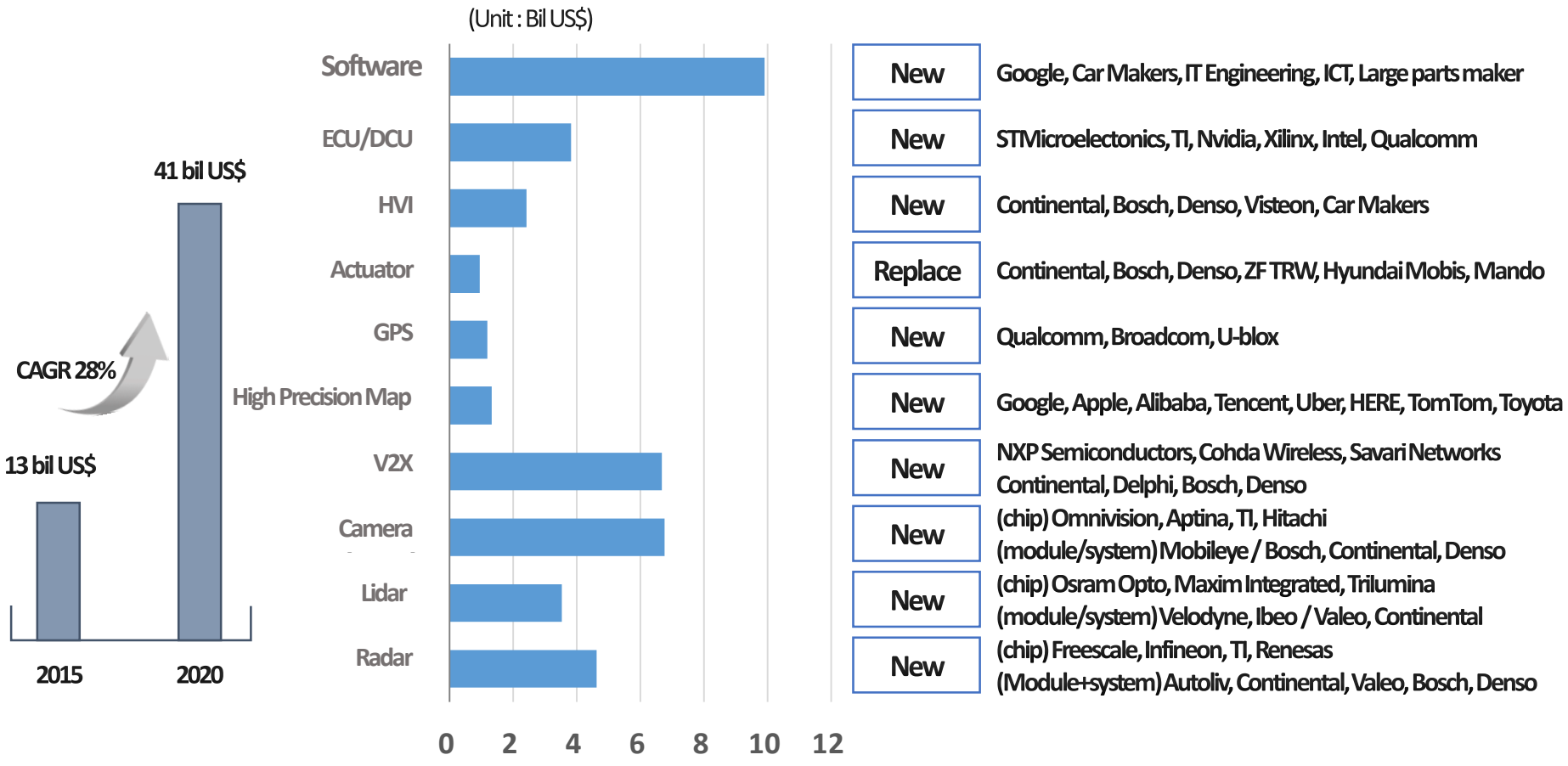
The goal is to provide fully autonomous technology in the form of solutions for global taxi, logistics vehicle and car companies.

Many companies are participating in autonomous driving technology in Korea.

Autonomous Driving technology		Major Global Companies	Local Companies
Radar	Chip	Freescale, Infineon, TI, Renesas	Nepes
	Module/System	Autoliv, Continental, Hella, Valeo, Bosch, Fujitsu Ten, Denso, Delphi	Acetech
Lidar	Chip	Osram Opto, Maxim Integrated, Trilumina	i3System, Truwin
	Module	Velodyne, ASC, Ibeo, Quanergy, SICK, Luminar Technology, Innoviz	SOS Lab
	System	Valeo, Continental, Denso	Hyvision Sytem, NC&, Carnavicom, JSLidar
Camera	Chip	Omnivision, Aptina, TI, Hitachi	Chips&Media, Uniquest
	Module	Mobileye	MCnex, Sekonix
	System	Bosch, Continental, Denso, Delphi	THE MIDONG
ADR		Tuxera	ESV, DSeltec, Mobileappliance, Cammsys
V2X Communication module	Communication control device	NXP semiconductors, Cohda Wireless, NXP-Cohda, Savari Networks	Chemtronics
	Communication system	Delphi, Denso, Continental, Bosch	HancomMDS, Korea Technology
High Precision digital Map		Google, Apple, Alibaba, Uber, Bosch, BMW-Audi-Daimler, Toyota	Hyundai MnSOFT
Complex positioning module	Chip	Qualcomm, Avago Technology, U-blox	
	Software	Google, Daimler etc. Car makers	
Smart Actuator		Bosch, Continental, Denso, ZF TRW	Hyundai Mobis, Mando
HVI Module	Display	Japan Display, AUO, Sharp, Innolux, Tianma, CPT	LG Display, Samsung Dispaly
	System	Bosch, Continental, Denso, Visteon	Esmo
DCU	H/W	Intel, Qualcomm, TI, STMicroelectonics, Nvidia, Xilinx	Samsung Electronics
	S/W	Google, Mobileye, Elektrobit, Apple, Baidu, Uber, Car makers	

The market opportunity for autonomous vehicle technology is expected to grow rapidly from US $ 12.9bn in 2015 to US $ 41bn in 2020 (CAGR 28%).

Market opportunities related to autonomous vehicles(2020)



The car sharing market is expected to grow to 1,400 bil $ in 2030.

Car sharing is a service that shares the vehicle itself. Ride sharing is a platform service that connects mobile service providers with customers who want to move.

Car Sharing Service

Ride Sharing Service

Company	Country	Service Area	Cars (thousand)
Car2go	Germany	8 countries	14
Drivenow	Germany	9 countries	6
Zipcar	USA	9 countries	10
Socar	Korea	1 country	8
Greencar	Korea	1 country	5

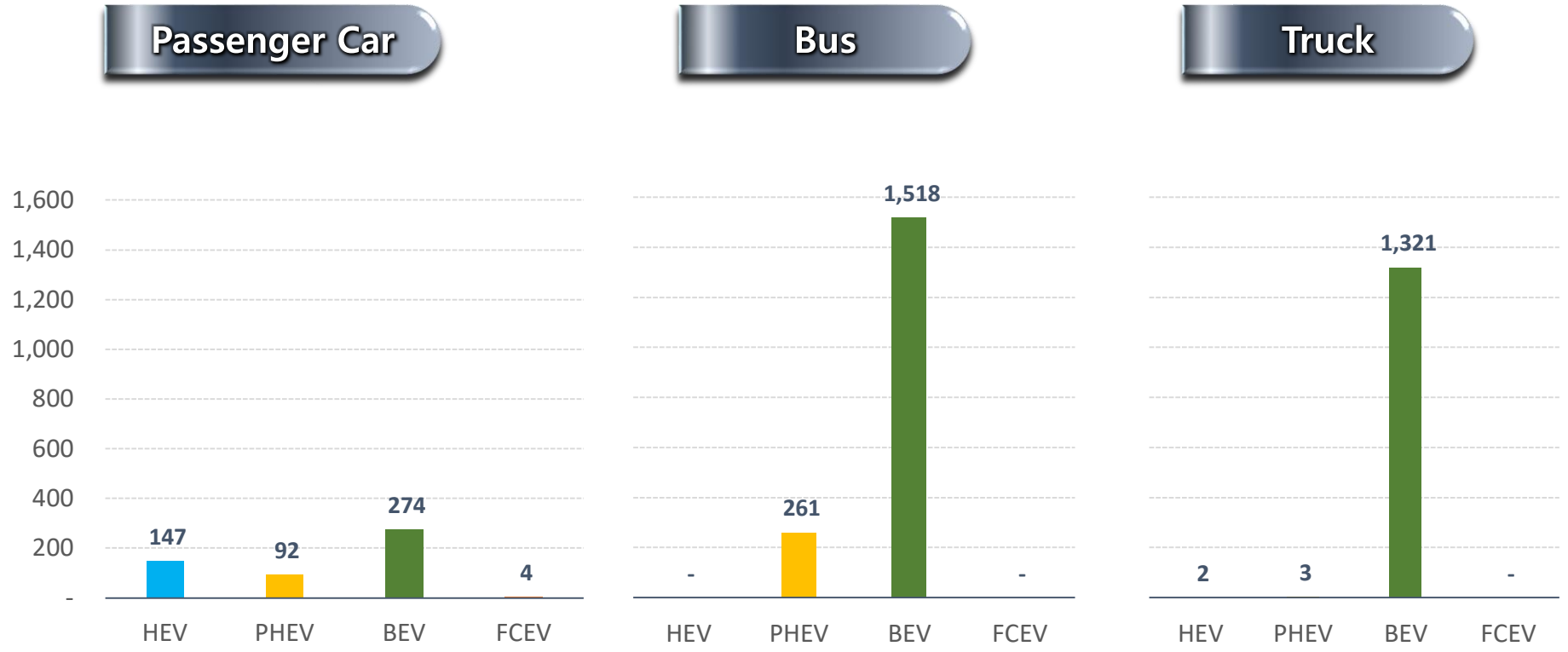
Company	Country	Service Area	Drivers (thousand)
Uber	USA	83 countries (674 cities)	2,000
Lyft	USA	USA (300 cities)	1,400
DiDi Chuxing	China	China (400 cities)	2,100
Grab	Singapore	8 countries (168 cities)	2,300
Oola	India	India/Australia (106 cities)	600

Plus, Luxy, Tikle, Kakao mobility, People Car, Carsum, Naver, Cube, DelCar

(Source : Wikipedia etc. (based on 2017))

As of the end of 2018, 3,622 electric models have been launched worldwide.

517 models of passenger cars, 1779 models of buses, 1326 models of trucks



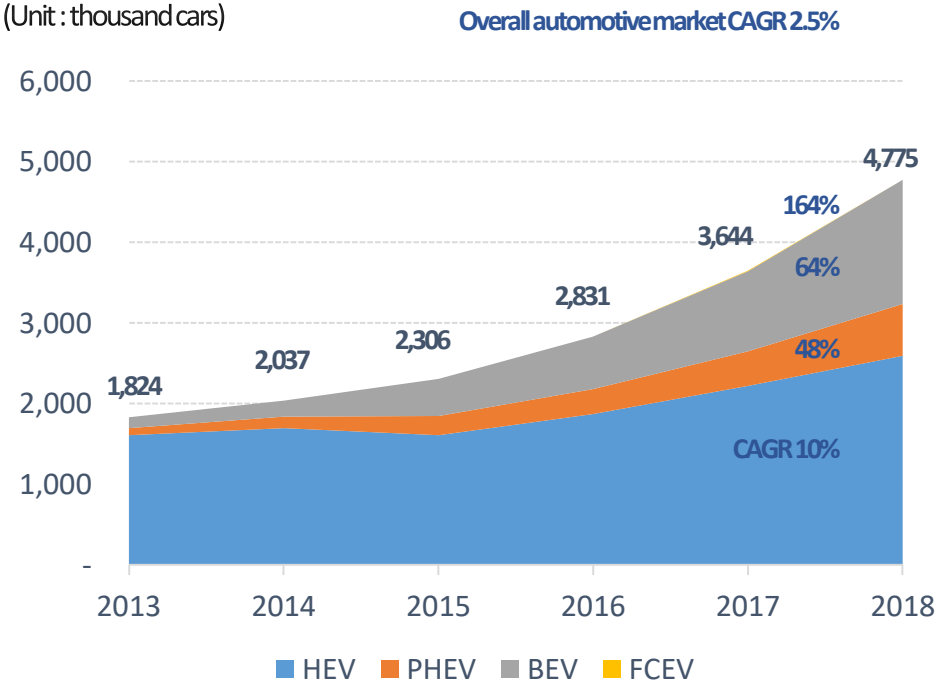
(Source : INI R&C)

EV reached 4.8 million cars world widely by 2018, reaching 5.0% of total vehicle sales.

Electric vehicles, which have been on sale since December 1997, reach 2% of total car sales in 2013 after 16 years, followed by 3years for 1% increase, and by 1 year after 2016.

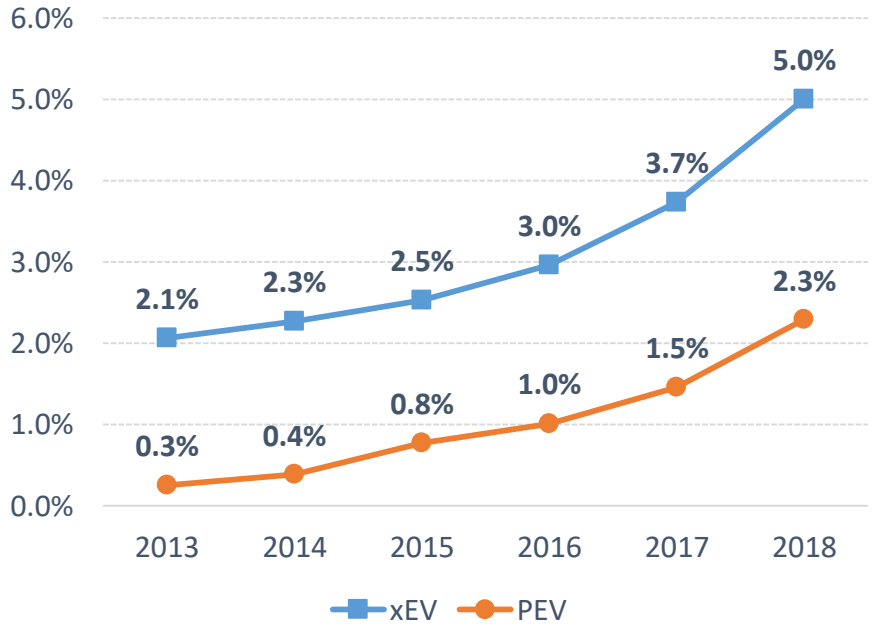
EV Market Trend

(Unit : thousand cars)



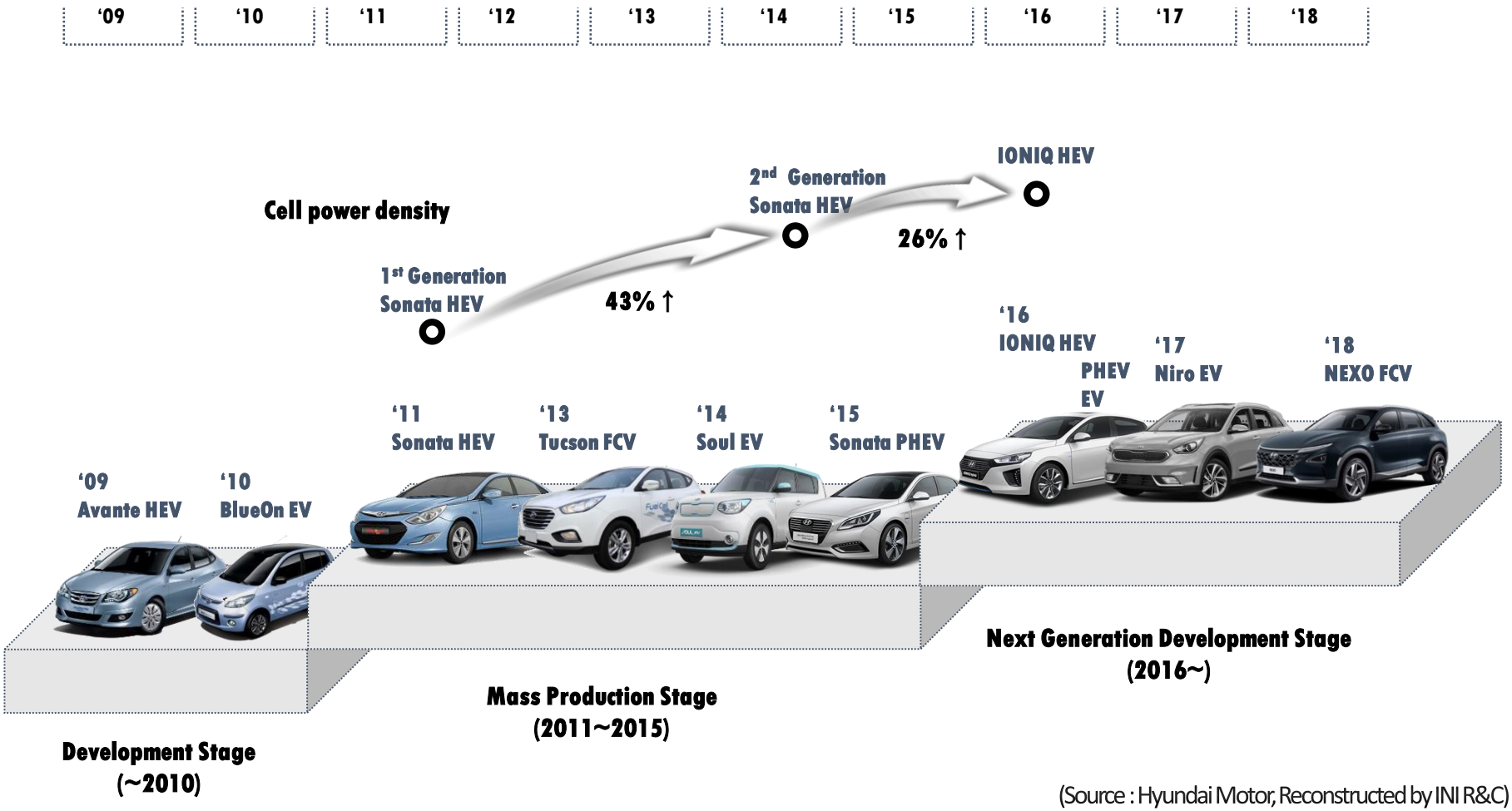
EV market penetration rate

* PEV = PHEV + BEV



(Source : INI R&C)

They are focusing on increasing the power density.

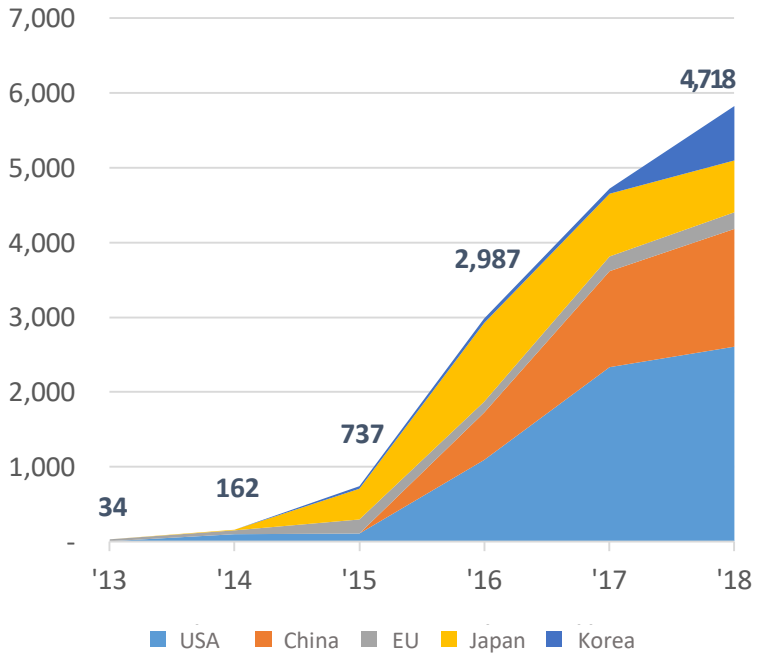


(Source : Hyundai Motor, Reconstructed by INI R&C)

Growth of the hydrogen electric vehicle (FCEV) market depends on cost.

The biggest problem is the cost of hydrogen delivery.

Sales Trend of FCEV



(Unit : INI R&C)

Challenge of FCEV

Safety

- Hydrogen is very light with only 1/14 of the air, so it rises immediately. The possibility of gas explosion is very low.
- In Germany and Japan, charging stations are installed and operated in urban areas.

Cost of FCEV

- Expected to decline in manufacturing costs through economies of scale
- However, it is necessary reduce the price of fuel cell stack (40% of manufacturing cost).

Cost of H_2 Station

- Charging station investment cost of 200~300 thousand $ → Payback is getting longer.
- Approximately 5,000 filling stations around the world in 2030 (12,000 gas stations only in Korea)

Cost of H_2

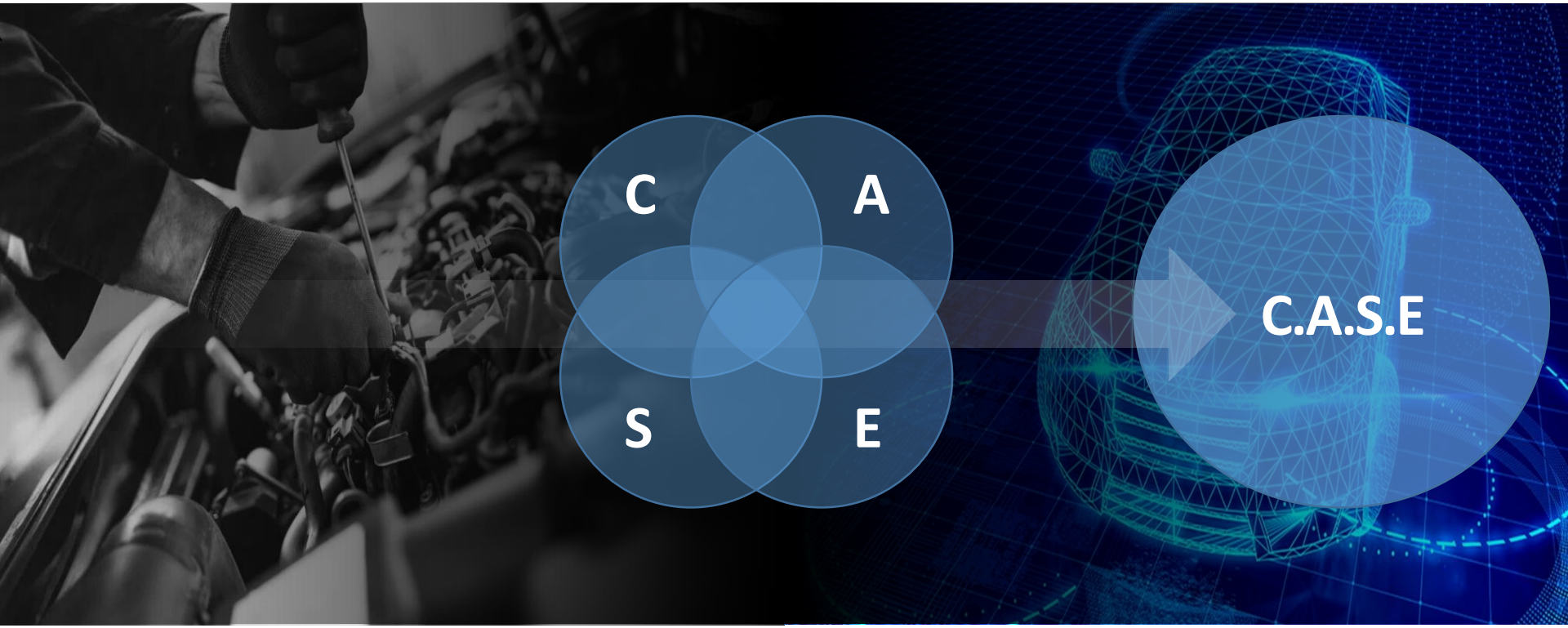
- The hydrogen production cost is 3 US $ per kg.
- Hydrogen transportation price and selling price (charging station, operating cost, etc.) are added and sold for 8~10 $.

The automotive industry is evolving from the machinery industry to the ICT & electronics industry, and the evolution will soon be completed.

Four areas of CASE will eventually become convergence.

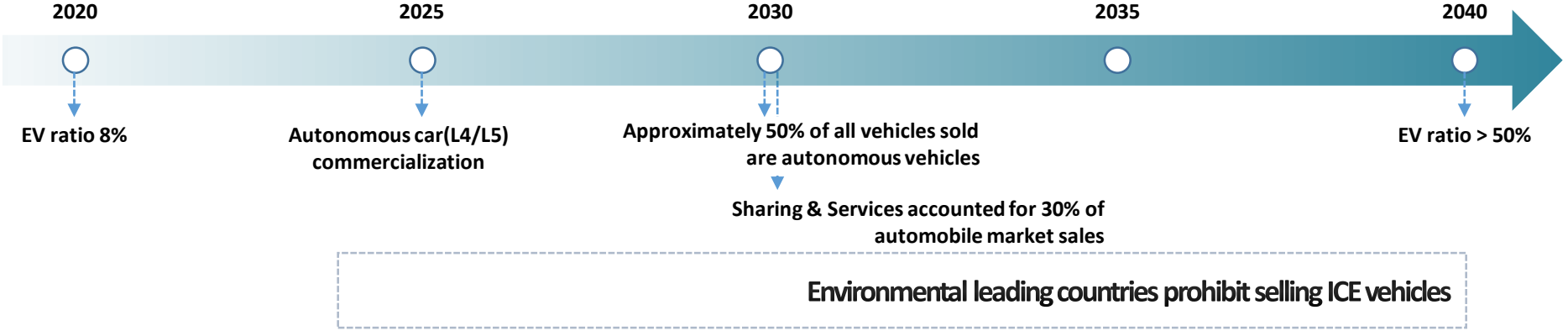
Engine

Semiconductor e-motor Battery Sensors Telecoms Big data AI Robot IoT

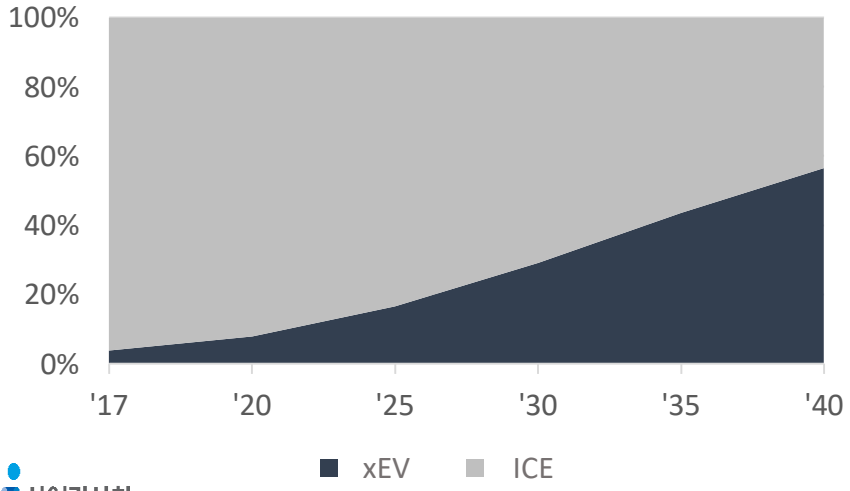


EV steadily make the market, but autonomous vehicles will rapidly penetrate the market.

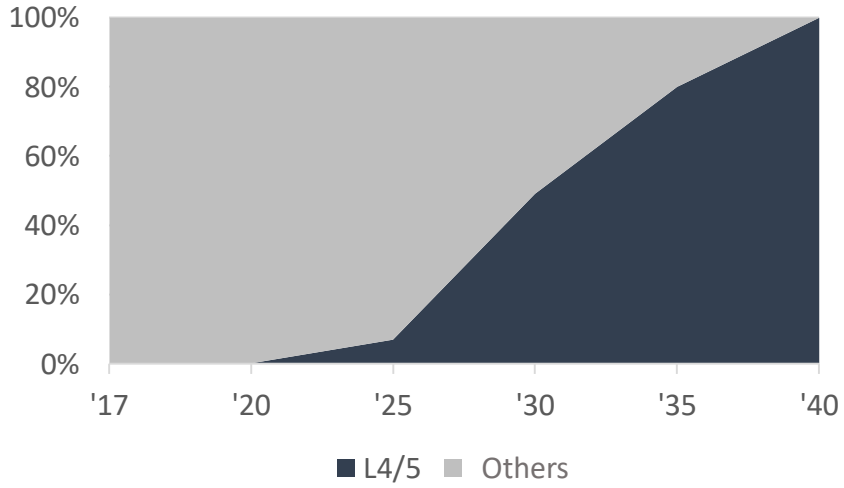
As a result, in the manufacturing side, as the era of electric cars and autonomous vehicles began, the expansion of the sharing service industry based on shared economy.



Electric Vehicles



Autonomous Vehicles



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